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In re application of
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SUBSTRATE PROCESSING METHOD AND SUBSTRATE PROCESSING APPARATUS

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VERIFYING DECLARATION

Commissioner for Patents
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Sir:

I, Ryoji Kosugi, declare and say:

that I am thoroughly conversant in both the Japanese and English languages;

that I am presently engaged as a translator in these languages;

that the attached document represents a true English translation of Japanese Patent Application No. 2003-78485 filed on March 20, 2003.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that there statements were made with the knowledge that willful false statements and like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 14th day of July, 2008

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TRANSLATOR

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(TITLE OF THE INVENTION) SUBSTRATE PROCESSING METHOD AND SUBSTRATE PROCESSING APPARATUS

(CLAIMS)

(CLAIM 1) A substrate processing method for forming a protective film on bottom surfaces and side surfaces of recesses for embedded interconnects provided in a surface of a substrate or exposed surfaces of interconnects provided in a surface of a substrate, comprising:

performing a catalyst imparting treatment by bringing a pretreatment liquid into contact with a base surface to be plated of the dry substrate to activate the surface, and removing the pretreatment liquid remaining on the surface of the substrate in a rinsing treatment;

performing an electroless plating process on the base surface to be processed, to which the catalyst has been imparted, to form said protective film selectively; and

post-cleaning the substrate after the electroless plating process and drying the substrate.

(CLAIM 2) A substrate processing method according to claim 1, wherein said catalyst imparting treatment is performed using the pretreatment liquid which is prepared by mixing at least together catalytic metal ions and an acid having a function to remove a metal oxide film on the base surface to be plated or metal residues on the base surface to be plated.

(CLAIM 3) A substrate processing method according to claim 1 or 2, wherein said rinsing treatment of said pretreatment liquid is performed by cleaning the surface of the substrate with pure water or pure water having a reducing capability increased by electrolysis or dissolving a hydrogen gas.

(CLAIM 4) A substrate processing method according to claim 1 or 2, wherein said rinsing treatment of said pretreatment liquid is performed by cleaning the surface of the

substrate with an aqueous liquid prepared by mixing one component or some components of an electroless plating solution.

(CLAIM 5) A substrate processing method according to any of claims 1 to 4, wherein said catalyst imparting treatment and said rinsing treatment are performed in an atmosphere having less oxygen than the atmosphere.

(CLAIM 6) A substrate processing method according to any of claims 1 to 5, wherein said electroless plating process is performed in an atmosphere having less oxygen than the atmosphere.

(CLAIM 7) A substrate processing method according to any of claims 1 to 6, wherein said catalyst imparting treatment is performed by ejecting the pretreatment liquid from a nozzle toward the surface of the substrate with processed surface having devices of the substrate facing downwardly, and then said rinsing treatment is performed by ejecting a rinsing liquid from a nozzle to the surface, to which the catalyst has been imparted, of the substrate.

(CLAIM 8) A substrate processing method according to claim 7, wherein the nozzle used in said catalyst imparting treatment and the nozzle used in said rinsing treatment are connected to respective different flow path systems.

(CLAIM 9) A substrate processing method according to any of claims 1 to 8, wherein a film thickness of said protective film is measured after the substrate is post-cleaned and dried.

(CLAIM 10) A substrate processing method according to any of claims 1 to 9, wherein the compositions and component concentrations of said pretreatment liquid and a rinsing liquid therefore are kept in predetermined ranges.

(CLAIM 11) A substrate processing method according to any of claims 1 to 10, wherein the concentration of an impurity mixed in said pretreatment liquid in said catalyst imparting treatment is measured, and the impurity is removed when the impurity reaches a predetermined concentration.

(CLAIM 12) A substrate processing method according to any of claims 1 to 11, wherein said electroless plating process is performed by keeping the temperature, composition, and component concentrations of a plating solution in predetermined ranges, and controlling a plating process time.

(CLAIM 13) A substrate processing method according to any of claims 1 to 12, wherein a series of processes from bringing the substrate into contact with the pretreatment solution to drying substrate are performed without exposing the surface to be processed of the substrate to light.

(CLAIM 14) A substrate processing apparatus, comprising:

a pretreatment unit for performing a catalyst imparting treatment by bringing a base surface to be processed of a substrate contact with a pretreatment liquid to activate the base surface to be processed, and a rinsing treatment for rinsing the pretreatment liquid remaining on the surface of the substrate after the catalyst imparting treatment;

an electroless plating unit for performing an electroless plating process on the surface of the substrate after the catalyst imparting treatment to selectively form a protective film on the base surface to be processed of the substrate; and

a post-treatment unit for post-cleaning the substrate after the electroless plating process and drying the substrate.

(CLAIM 15) A substrate processing apparatus according to claim 14, further comprises a device for measuring a film thickness of a protective film formed on the substrate dried by said post-treatment unit.

(CLAIM 16) A substrate processing apparatus according to claim 14 or 15, wherein said pretreatment unit has a function to separate the pretreatment liquid used in said catalyst imparting treatment and a rinsing liquid used in said rinsing treatment from each other after the substrate is treated.

(CLAIM 17) A substrate processing apparatus according to any of claims 14 to 16, wherein said pretreatment unit includes a liquid purifying device having a liquid purifying function to measure the concentration of an impurity mixed in said pretreatment liquid in

said catalyst imparting treatment and to remove the impurity when the concentration of the impurity reaches a predetermined value.

(CLAIM 18) A substrate processing apparatus according to any of claims 14 to 17, wherein said device for measuring a film thickness of a protective film measures a film thickness of a protective film formed on the base surface to be plated of the substrate.

(CLAIM 19) A substrate processing apparatus according to any of claims 14 to 18, wherein said pretreatment unit and said electroless plating unit are arranged to process the surface of the substrate which faces in the same orientation.

(CLAIM 20) A substrate processing apparatus according to any of claims 14 to 19, wherein said pretreatment unit and said electroless plating unit have a common substrate holding head.

(CLAIM 21) A substrate processing apparatus according to any of claims 14 to 20, wherein said substrate holding head is arranged to seal simultaneously or selectively one of a peripheral portion of a face side of the substrate and a peripheral portion of a reverse side of the substrate.

(CLAIM 22) A substrate processing apparatus according to any of claims 14 to 21, wherein said pretreatment unit and said electroless plating unit are disposed in a closable housing.

(CLAIM 23) A substrate processing apparatus according to claims 14 to 22, wherein the substrate processing apparatus is housed in a housing shielded against transmission of light from an external environment.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD TO WHICH THE INVENTION BELONGS)

The present invention relates to a substrate processing method and a substrate processing apparatus, and more particularly to a substrate processing method and a substrate processing apparatus used for forming, on bottom surfaces and side surfaces or exposed surfaces of embedded interconnects which have been formed by embedding an

electrical conductor such as copper or silver into fine interconnect recesses provided in a surface of a substrate such as a semiconductor wafer, a conductive film having a function to prevent thermal diffusion of the interconnect material into an interlevel dielectric layer or a function to improve adhesiveness between the interconnects and an interlevel dielectric layer, or a protective film such as a magnetic film covering the interconnects by electroless plating.

(0002)

(PRIOR ART)

As a process for forming interconnects in a semiconductor device, the so-called "damascene process", which comprises embedding a metal (conductive material) into interconnect trenches and contact holes, is coming into practical use. This process includes embedding aluminum or, more recently a metal such as copper or silver in trenches or contact holes, which have previously been formed in an interlevel dielectric layer, and then removing extra metal by chemical mechanical polishing (CMP) so as to flatten a surface of a substrate.

(0003)

In a case of such interconnects, for example, copper interconnects, which use copper as an interconnect material, in order to improve the reliability, there has been employed a method in which a barrier film is formed on bottom surfaces and side surfaces of the interconnects to prevent thermal diffusion of the interconnects (copper) into an interlevel dielectric layer and to improve electromigration resistance of the interconnects, or a method in which an anti-oxidizing film is formed to prevent oxidation of the interconnects (copper) under an oxidizing atmosphere so as to produce a semiconductor device having a multi-level interconnect structure in which insulating films (oxide films) are subsequently laminated. Generally, metal such as tantalum, titanium, or tungsten, or nitride thereof has heretofore been used as this type of barrier film. Nitride of silicon has generally been used as an anti-oxidizing film.

(0004)

As an alternative of the above methods, there has been studied a method in which bottom surfaces and side surfaces or exposed surfaces of embedded interconnects are selectively covered with an interconnect-protective film made of a cobalt alloy, a nickel alloy, or the like to prevent thermal diffusion, electromigration, and oxidation of the interconnects. With regard to a non-volatile magnetic memory, when memory cells are mounted with high density and a design rule is small, an electric density of copper interconnects increases causing the problem of electromigration. Furthermore, when a memory cell is small, a writing current increases during writing, and a crosstalk is a problem due to the approach of the cells. To solve this problem, it is considered that a yoke structure, in which portions around copper interconnects are covered with a magnetic film such as a cobalt alloy or a nickel alloy, is effective. The magnetic film is formed, for example, by electroless plating.

(0005)

For example, as shown in FIG. 1, fine interconnect recesses 4 are formed in an insulating film 2 made of SiO_2 or the like, which has been deposited on a surface of a substrate W such as a semiconductor wafer. A barrier layer 6 of TaN or the like is formed on a surface of the insulating film 2. Then, copper plating is carried out to deposit a copper film on the surface of the substrate W so as to embed copper film in the recesses 4. Thereafter, CMP (chemical mechanical polishing) is carried out on the surface of the substrate W to remove an extra metal, thereby forming interconnects 8 made of copper film in the insulating film 2. An interconnect-protective film (cap material) 9 of a Co-W-P alloy film, which is obtained, for example, by electroless plating, is formed selectively on surfaces of the interconnects (copper film) 8 so as to protect the interconnects 8.

(0006)

There will be described a process of forming an interconnect-protective film (cap material) 9 of a Co-W-P alloy film selectively on surfaces of interconnects 8 by using a conventional electroless plating method. First, the substrate W such as a semiconductor wafer, which has been carried out a CMP process, is immersed, for example, in dilute

sulfuric acid or dilute hydrochloric acid having an ordinary temperature for about one minute to remove impurities such as a metal oxide film on a surface of an insulating film 2 and CMP residues such as of copper. After the surface of the substrate W is cleaned with a cleaning liquid such as pure water, the substrate W is immersed, for example, in a $PdCl_2/HCl$ mixed solution having an ordinary temperature for about one minute to adhere Pd as a catalyst to the surfaces of the interconnects 8 so as to activate exposed surfaces of the interconnects 8. After the surface of the substrate W is cleaned (rinsed) with pure water or the like, the substrate W is immersed, for example, in a Co-W-P plating solution at 80°C for about 120 seconds to carry out electroless plating selectively on surfaces of the activated interconnects 8. Thereafter, the surface of the substrate W is cleaned with a cleaning liquid such as pure water. Thus, an interconnect-protective film 9 made of a Co-W-P alloy film is formed selectively on the exposed surfaces of the interconnects 8 so as to protect the interconnects 8.

(0007)

(PROBLEM TO BE SOLVED BY THE INVENTION)

When an interconnect-protective film (cap material) of a Co-W-P alloy film is formed by performing electroless plating, as described above, it is the practice to perform a treatment for removing an oxide film on the interconnects, for example, and a catalyst imparting treatment for imparting a catalyst such as Pd or the like to the surfaces of the interconnects. It is necessary to remove CMP residues such as of copper remaining on an insulating film in order to prevent an interconnect-protective film from being formed on the insulating film. This treatment generally carried out using an inorganic acid such as HF, H_2SO_4 or HCl. If the chemical solution or the plating solution remains on the surface of the substrate after the chemical solution treatment or the plating process, then the within-wafer uniformity, the electrical characteristics of interconnects or the like is adversely affected. Consequently, it is necessary to quickly remove the chemical solution or the plating solution remaining on the surface of the substrate. If the above various processes are performed by respective dedicated units, then not only the number of processing tanks

in the respective processes is increased, but also a limitation is imposed on efforts to shorten the time to transfer substrates with a transfer robot. As a result, not only the apparatus footprint is increased and the processing throughput is lowered, but also process control between the processes is complicated. In particular, if the substrate is left in an oxygen atmosphere for a long time between the catalyst applying treatment and the rinsing treatment or between the rinsing treatment and the plating process, then the surface state of the substrate is liable to change, and the electrical characteristics of the interconnects on the processed substrate are possibly adversely affected.

(0008)

The present invention has been made in view of the above drawbacks. It is an object of the present invention to provide a substrate processing method and a substrate processing apparatus which are capable of lowering the initial cost and the running cost of the apparatus, do not require a wide installation space, do not particularly degrade electrical characteristics of the interconnects, and are capable of efficiently forming a high-quality protective film.

(0009)

(MEANS FOR SOLVING THE PROBLEM)

The present invention described in claim 1 provides a substrate processing method for forming a protective film on bottom surfaces and side surfaces of recesses for embedded interconnects provided in a surface of a substrate or exposed surfaces of interconnects provided in a surface of a substrate, comprising: performing a catalyst imparting treatment by bringing a pretreatment liquid into contact with a base surface to be plated of the dry substrate to activate the surface, and removing the pretreatment liquid remaining on the surface of the substrate in a rinsing treatment; performing an electroless plating process on the base surface to be processed, to which the catalyst has been imparted, to form the protective film selectively; and post-cleaning the substrate after the electroless plating process and drying the substrate.

With the above arrangement, the initial cost and running cost of the apparatus are held to a low level, and a series of processes until forming a protective film by electroless process on the base surface of the substrate can successively be performed without the need for a wide installation space.

(0010)

The present invention described in claim 2 provides a substrate processing method according to claim 1, wherein the catalyst imparting treatment is performed using the pretreatment liquid which is prepared by mixing at least together catalytic metal ions and an acid having a function to remove a metal oxide film on the base surface to be plated or metal residues on the base surface to be plated. With this arrangement, a catalyst is imparted to the base surface of the substrate, and simultaneously the oxide film on the interconnect metal is removed and the metal residues on the interlevel dielectric layer are removed.

(0011)

The present invention described in claim 3 provides a substrate processing method according to claim 1 or 2, wherein the rinsing treatment of the pretreatment liquid is performed by cleaning the surface of the substrate with pure water or pure water having a reducing capability increased by electrolysis or dissolving a hydrogen gas. It is thus possible to efficiently clean away the pretreatment liquid remaining on the substrate while preventing the interconnects from being oxidized and also to prevent the acid pretreatment liquid from finding its way into the plating solution to keep the plating solution stable.

(0012)

The present invention described in claim 4 provides a substrate processing method according to claim 1 or 2, wherein the rinsing treatment of the pretreatment liquid is performed by cleaning the surface of the substrate with an aqueous liquid prepared by mixing one component or some components of an electroless plating solution. It is thus possible to efficiently clean away the pretreatment liquid remaining on the substrate while preventing the interconnects from being oxidized.

(0013)

The present invention described in claim 5 provides a substrate processing method according to any of claims 1 to 4, wherein the catalyst imparting treatment and the rinsing treatment are performed in an atmosphere having less oxygen than the atmosphere. It is thus possible to suppress the regeneration of an oxide film on the base surface to which the catalyst has been imparted by the catalyst imparting treatment.

(0014)

The present invention described in claim 6 provides a substrate processing method according to any of claims 1 to 5, wherein the electroless plating process is performed in an atmosphere having less oxygen than the atmosphere. It is thus possible to prevent the protective film from being oxidized during its deposition for thereby forming a protective film of stable film property.

(0015)

The present invention described in claim 7 provides a substrate processing method according to any of claims 1 to 6, wherein the catalyst imparting treatment is performed by ejecting the pretreatment liquid from a nozzle toward the surface of the substrate with processed surface having devices of the substrate facing downwardly, and then the rinsing treatment is performed by ejecting a rinsing liquid from a nozzle to the surface, to which the catalyst has been imparted, of the substrate. By thus performing the catalyst imparting treatment or the rinsing treatment in such a spray-type application, the treatment liquid which is fresh at all times can be uniformly distributed and supplied to the surface of the substrate for a reduced processing time. The uniformity of the within-wafer processing can easily be improved by adjusting the position of the ejection point.

(0016)

The present invention described in claim 8 provides a substrate processing method according to claim 7, wherein the nozzle used in the catalyst imparting treatment and the nozzle used in the rinsing treatment are connected to respective different flow path systems. With this arrangement, the nozzle system used in the rinsing treatment is

prevented from being contaminated by the pretreatment liquid, allowing the rinsing liquid to keep a stable cleaning ability.

(0017)

The present invention described in claim 9 provides a substrate processing method according to any of claims 1 to 8, wherein a film thickness of the protective film is measured after the substrate is post-cleaned and dried. By measuring the film thickness of the protective film formed on the base surface of the substrate and adjusting the processing time of the plating process on a next substrate, for example, depending on a change in the film thickness, the film thickness of the protective film to be formed on the surfaces of interconnects can be controlled.

(0018)

The present invention described in claim 10 provides a substrate processing method according to any of claims 1 to 9, wherein the compositions and component concentrations of the pretreatment liquid and a rinsing liquid therefore are kept in predetermined ranges. It is thus possible to impart a catalyst with stable nuclear density to the base surface of the substrate to form a protective film having stable film properties and uniform film thickness.

(0019)

The present invention described in claim 11 provides a substrate processing method according to any of claims 1 to 10, wherein the concentration of an impurity mixed in the pretreatment liquid in the catalyst imparting treatment is measured, and the impurity is removed when the impurity reaches a predetermined concentration. It is thus possible to prevent the function of the expensive pretreatment liquid from being lowered, and to use the pretreatment liquid stably over a long period.

(0020)

The present invention described in claim 12 provides a substrate processing method according to any of claims 1 to 11, wherein the electroless plating process is performed by keeping the temperature, composition, and component concentrations of a plating solution in predetermined ranges, and controlling a plating process time. By thus controlling the

plating time, a film thickness of the protective film formed on the base surface of the substrate can be adjusted.

(0021)

The present invention described in claim 13 provides a substrate processing method according to any of claims 1 to 12, wherein a series of processes from bringing the substrate into contact with the pretreatment solution to drying substrate are performed without exposing the surface to be processed of the substrate to light. It is thus possible to eliminate the light-excited motion of electrons in devices and interconnects formed in a device surface of the substrate while the substrate is being processed, preventing damage from being made to the substrate devices.

(0022)

The present invention described in claim 14 provides a substrate processing apparatus, comprising: a pretreatment unit for performing a catalyst imparting treatment by bringing a base surface to be processed of a substrate contact with a pretreatment liquid to activate the base surface to be processed, and a rinsing treatment for rinsing the pretreatment liquid remaining on the surface of the substrate after the catalyst imparting treatment; an electroless plating unit for performing an electroless plating process on the surface of the substrate after the catalyst imparting treatment to selectively form a protective film on the base surface to be processed of the substrate; and a post-treatment unit for post-cleaning the substrate after the electroless plating process and drying the substrate.

With the above arrangement, the overall apparatus is more compact, does not require a wide installation space, has a lower initial cost and a lower running cost, and can form a protective film within a shorter processing time, than would be if the processing steps were performed by separate units (processing units). In particular, since waiting times or transfer times for the substrate between the processing steps can be adjusted to extremely short times, it is possible to form a high-quality protective film without causing its electrical characteristics from being degraded.

(0023)

The present invention described in claim 15 provides a substrate processing apparatus according to claim 14, further comprises a device for measuring a film thickness of a protective film formed on the substrate dried by the post-treatment unit. It is thus possible to realize a highly reproducible deposited film.

(0024)

The present invention described in claim 16 provides a substrate processing apparatus according to claim 14 or 15, wherein the pretreatment unit has a function to separate the pretreatment liquid used in the catalyst imparting treatment and a rinsing liquid used in the rinsing treatment from each other after the substrate is treated. It is thus possible to perform the catalyst imparting treatment of the substrate and the rinsing treatment successively within a single processing unit, and to individually retrieve the processing liquids (the pretreatment liquid and the rinsing liquid) for reuse. Furthermore, the time between the catalyst imparting treatment and the rinsing treatment on the substrate can be adjusted to an extremely short time.

(0025)

The present invention described in claim 17 provides a substrate processing apparatus according to any of claims 14 to 16, wherein the pretreatment unit includes a liquid purifying device having a liquid purifying function to measure the concentration of an impurity mixed in the pretreatment liquid in the catalyst imparting treatment and to remove the impurity when the concentration of the impurity reaches a predetermined value. It is thus possible to suppress contamination of the pretreatment liquid used in the catalyst imparting treatment and to enable the pretreatment liquid to have stable catalyzing power.

(0026)

The present invention described in claim 18 provides a substrate processing apparatus according to any of claims 14 to 17, wherein the device for measuring a film thickness of a protective film measures a film thickness of a protective film formed on the

base surface to be plated of the substrate. By measuring the film thickness of the protective film formed on the base surface of the substrate and adjusting the processing time of the plating process on a next substrate, for example, depending on a change in the film thickness, the film thickness of the protective film to be formed on the base surface of the substrate can be controlled.

(0027)

The present invention described in claim 19 provides a substrate processing apparatus according to any of claims 14 to 18, wherein the pretreatment unit and the electroless plating unit are arranged to process the surface of the substrate which faces in the same orientation. It is thus possible to process the substrate with the pretreatment unit and the electroless plating unit without inverting the substrate through 180° but keeping the surface of the substrate facing downwardly, for example, thus shortening the transfer time for the substrate and suppressing changes in the state of the substrate.

(0028)

The present invention described in claim 20 provides a substrate processing apparatus according to any of claims 14 to 19, wherein the pretreatment unit and the electroless plating unit have a common substrate holding head. It is thus possible to adjust the time interval after the pretreatment liquid is rinsed away until the plating process is started, to an extremely short time for forming a protective film of stable film property. Furthermore, contamination or damage of the reverse side of the substrate can be avoided.

(0029)

The present invention described in claim 21 provides a substrate processing apparatus according to any of claims 14 to 20, wherein the substrate holding head is arranged to seal simultaneously or selectively one of a peripheral portion of a face side of the substrate and a peripheral portion of a reverse side of the substrate. By performing the catalyst imparting treatment with the pretreatment unit while sealing the peripheral portion of the face side of the substrate and also performing the rinsing treatment with the pretreatment unit and the plating process with the electroless plating unit while sealing the

peripheral portion of the reverse side of the substrate, for example, it is possible to prevent an abnormal plated film from being produced on the peripheral portion of the substrate.

(0030)

The present invention described in claim 22 provides a substrate processing apparatus according to any of claims 14 to 21, wherein the pretreatment unit and the electroless plating unit are disposed in a closable housing. By transferring the substrate after it is rinsed by the pretreatment liquid to the electroless plating unit in an atmosphere which contains less oxygen than the atmosphere, the substrate being processed is prevented from being exposed to an oxidizing atmosphere, and a protective film of stable film property is obtained.

(0031)

The present invention described in claim 23 provides a substrate processing apparatus according to claims 14 to 22, wherein the substrate processing apparatus is housed in a housing shielded against transmission of light from an external environment. It is thus possible to eliminate the light-excited motion of electrons in devices and interconnects formed in a device surface of the substrate while the substrate is being processed, preventing damage from being made to the substrate devices.

(0032)

(EMBODIMENTS)

An embodiment of the present invention will be described below with reference to the drawings.

FIG. 2 is a plan view showing the layout of a substrate processing apparatus according to an embodiment of the present invention. As shown in FIG. 2, the substrate processing apparatus includes a loading/unloading unit 12 for placing and housing a substrate cassette 10 which houses therein substrates W (see FIG. 1) each having interconnects 8 made of copper or the like in interconnect recesses 4 that are defined in the surface of the substrate W. Within a rectangular housing 16 having an air discharge system, there are disposed a pretreatment unit 18 for simultaneously performing

pretreatments on the substrate W prior to a plating process, e.g., a purifying treatment and a catalyst imparting treatment, using the same pretreatment liquid, an electroless plating unit 20 for performing an electroless plating process on the surface (to be processed) of the substrate W, a film thickness measuring unit 22 for measuring a film thickness of a protective film 9 (see FIG. 1) which is formed on surfaces of interconnects 8 by the electroless plating process, and a post-cleaning unit (post-treatment unit) 24 for post-cleaning and drying the substrate W after it is plated. A first transfer robot 26 is disposed in a position sandwiched between the loading/unloading unit 12 and the film thickness measuring unit 22, and a second transfer robot 28 is disposed in a position sandwiched between the pretreatment unit 18, the electroless plating unit 20, the film thickness measuring unit 22, and the post-cleaning unit 24.

(0033)

The housing 16 is shielded against transmission of light from an external environment. This can eliminate the light-excited motion of electrons in devices and interconnects formed in a device surface of the substrate while the substrate is being processed, preventing damage from being made to the substrate devices.

(0034)

A vertically movable and angularly movable turn shaft 30 is vertically mounted laterally of the pretreatment unit 18 and the electroless plating unit 20, and a swing arm 32 is fixed to the upper end of the turn shaft 30. The swing arm 32 has a free end with a downwardly oriented motor 34 mounted thereon. The motor 34 has an output shaft 36 having a lower end on which there is mounted a substrate holding head 38 for detachably holding the substrate W. The substrate holding head 38 faces downwardly. When the turn shaft 30 is turned about its own axis, the swing arm 32 swings horizontally, moving the substrate holding head 38 between a position directly above the pretreatment unit 18 and a position directly above the electroless plating unit 20. Therefore, the pretreatment unit 18 and the electroless plating unit 20 have the common substrate holding head 38.

As shown in FIG. 6, the pretreatment unit 18 and the electroless plating unit 20, and the turn shaft 30, the swing shaft 32, and the substrate holding head 38 are disposed in a space partitioned by a partition wall 42. The space has an air supply/discharge system 40, can be closed, and has its atmosphere independently controllable.

(0035)

The pretreatment unit 18 simultaneously performs pretreatments on the substrate W prior to a plating process, i.e., a purifying treatment for purifying the surfaces of the embedded interconnects 8 formed in the surface of the substrate W, and a catalyst imparting treatment for imparting a catalyst to the surfaces to be processed of the interconnects 8 to activate the surfaces after the purifying treatment. The pretreatment unit 18 also performs a rinsing treatment for rinsing away a pretreatment liquid (chemical solution) used to impart the catalyst, with a rinsing liquid. In this embodiment, these treatments are performed by the single pretreatment unit 18.

(0036)

The pretreatment unit 18 is of the two-liquid separating type for preventing different liquids from being mixed with each other. As shown in FIGS. 3 through 5, the pretreatment unit 18 has an upwardly open processing tank 100 (see FIG. 6) having an inside diameter slightly greater than the outside diameter of the substrate holding head 38. The processing tank 100 has an inner tank 100a and an outer tank 100b. A pair of legs 104 attached to a lid 102 is rotatably supported on an outer circumferential surface of the outer tank 100b. A crank 106 is integrally coupled to each leg 104 and has a free end rotatably coupled to a rod 110 of a lid moving cylinder 108. Thus, when the lid moving cylinders 108 are actuated, the lid 102 is moved between a processing position covering an upper end opening of the inner tank 100a and a retracted position laterally of the inner tank 100a. The lid 102 supports on its surface (upper surface) a nozzle plate 112 having a number of spray nozzles 112a for ejecting outwardly (upwardly) a rinsing liquid such as electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution, as described below.

(0037)

As shown in FIG. 6, the inner tank 100a accommodates therein a nozzle plate 124 having a plurality of spray nozzles 124a for ejecting upwardly a pretreatment liquid which is supplied from a pretreatment liquid tank 120 upon actuation of a pretreatment liquid supply pump 122, the spray nozzles 124a being distributed uniformly over the entire transverse plane of the inner tank 100a. A drainpipe 126 for discharging the pretreatment liquid (waste liquid) is connected to the bottom of the inner tank 100a. The drainpipe 126 has a three-way valve 128 having an outlet port connected to a return pipe 130 for returning the pretreatment liquid (waste liquid) to the pretreatment liquid tank 120 for reuse when necessary.

(0038)

The pretreatment liquid is a solution having catalytic metal ions and inorganic acid ions having a function to remove a metal oxide film on the surfaces of interconnects or metal residues remaining on the surfaces of interconnects. By bringing the pretreatment liquid into contact with the surface of the substrate, a catalyst is imparted to the surfaces of interconnects, and simultaneously the oxide film on the interconnect metal is removed and the metal residues on the interlevel dielectric layer are removed.

(0039)

In this embodiment, the nozzle plate 112 mounted on the surface (upper surface) of the lid 102 is connected to a rinsing liquid supply source 132. The pretreatment liquid, which remains on the surface of the substrate after the catalyst is imparted, is rinsed (cleaned) away using a rinsing liquid, e.g., electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution. A drainpipe 127 for discharging the rinsing liquid (waste liquid) is connected to the bottom of the outer tank 100b of the processing tank 100.

(0040)

Although electrolyzed ion water having reducing power is used as the rinsing liquid to efficiently clean the pretreatment liquid which remains on the substrate while preventing

the interconnects from being oxidized in this embodiment, reducing water ionized by a desired process or pure water may be used to rinse (clean) the surface of the substrate. Furthermore, the pretreatment liquid may be rinsed away by cleaning the surface of the substrate with an aqueous liquid comprising one component or mixed components of an electroless plating solution, thereby efficiently cleaning away the pretreatment liquid which remains on the substrate while preventing the interconnects from being oxidized.

(0041)

The substrate holding head 38 which is holding the substrate W is lowered and positioned in the inner tank 100a of the processing tank 100, and then the spray nozzles 124a of the nozzle plate 124 disposed in the inner tank 100a ejects the pretreatment liquid to the substrate W. The pretreatment liquid can thus uniformly be ejected to the entire lower surface (to be processed) of the substrate W, and can be discharged from the drainpipe 126 while it is prevented from being scattered outwardly. The substrate holding head 38 is lifted and the upper end opening of the inner tank 100a of the processing tank 100 is closed by the lid 102. The spray nozzles 112a of the nozzle plate 112 disposed on the upper surface of the lid 120 eject the rinsing liquid, such as electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution, to the substrate W held by the substrate holding head 38, thereby rinsing (cleaning) away the pretreatment liquid that remains on the surface of the substrate after the catalyst is imparted thereto. The rinsing liquid (waste liquid) after it has rinsed away the pretreatment liquid flows between the outer tank 100b and the inner tank 100a of the processing tank 100 and is collected into the bottom of the outer tank 100b, and then discharged through the drainpipe 127. In this manner, the rinsing liquid such as electrolyzed ion water having reducing power is prevented from flowing into the inner tank 100a of the processing tank 100, so that two liquids will not be mixed with each other therein.

(0042)

With the pretreatment unit 18, as shown in FIG. 3, while the substrate holding head 38 is lifted, the substrate W is inserted and held in the substrate holding head 38. Thereafter, as shown in FIG. 4, the substrate holding head 38 is lowered and positioned in the inner tank 100a of the processing tank 100 (see FIG. 6). The substrate holding head 38 is rotated to rotate the substrate W held thereby, and the spray nozzles 124a of the nozzle plate 124 disposed in the inner tank 100a ejects the pretreatment liquid to the substrate W, thereby applying the pretreatment liquid uniformly to the entire surface of the substrate W. The substrate holding head 38 is lifted and stopped at a predetermined position. As shown in FIG. 5, the lid 102 in the retracted position is moved to the position covering the upper end opening of the inner tank 100a of the processing tank 100. Then, the spray nozzles 112a of the nozzle plate 112 disposed on the upper surface of the lid 120 eject the rinsing liquid, such as electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution, to the substrate W held and rotated by the substrate holding head 38. The rinsing liquid after it has rinsed away the pretreatment liquid flows between the outer tank 100b and the inner tank 100a of the processing tank 100 and is collected into the bottom of the outer tank 100b, and then discharged. In this manner, the purifying treatment and the catalyst imparting treatment on the substrate W using the pretreatment liquid, and the rinsing treatment using the rinsing liquid, such as electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution, can be performed without mixing the two liquids with each other.

(0043)

The pretreatment liquid tank 120 is associated with a pretreatment liquid purifying device 140 for measuring the concentration of impurities such as of copper or the like which have been mixed in the pretreatment liquid during the catalyst imparting treatment and removing the impurities when the concentration thereof reaches a predetermined value. The pretreatment liquid purifying device 140 is capable of preventing the pretreatment liquid to be used in the catalyst imparting treatment from being contaminated

to allow the pretreatment liquid to have stable catalyzing power at all times. It is preferable to keep the temperature, composition, and component concentrations of the pretreatment liquid in predetermined ranges for imparting a catalyst with stable nuclear density to the interconnect surfaces to form a protective film having stable film properties and a uniform film thickness.

(0044)

The lowered position of the substrate holding head 38 can be adjusted to adjust the distance between the substrate W held by the substrate holding head 38 and the nozzle plate 124 for adjusting, as desired, the area in which the pretreatment liquid ejected from the spray nozzles 124a of the nozzle plate 124 and the ejected pressure of the pretreatment liquid.

(0045)

As shown in FIG. 6, the electroless plating unit 20 is associated with a plating tank 200 for storing therein a plating solution controlled at a predetermined temperature (e.g., 80°C). The plating tank 200 has a bottom connected to a plating solution supply pipe 208 extending from a plating solution supply tank 202 and having a plating solution supply pump 204 and a three-way valve 206. The plating tank 200 also has a plating solution retrieval groove 210 around its circumferential wall. In the plating process, the plating tank 200 is supplied with the plating solution from its bottom, and a plating solution overflowed from the plating tank 200 is retrieved from the plating solution retrieval groove 210 into the plating solution supply tank 202 for thereby circulating the plating solution. A plating solution return pipe 212 for returning the plating solution to the plating solution storage tank 202 is connected to one of the ports of the three-way valve 206. Thus, the plating solution can be circulated even in a standby condition of plating. By thus always circulating the plating solution in the plating solution storage tank 202, a lowering rate of the concentration of the plating solution can be reduced and the number of the substrates W which can be processed can be increased, compared with the case in which the plating solution is simply stored.

(0046)

A temperature sensor 214 for measuring the temperature of the plating solution introduced into the plating tank 200 and controlling a heater 216 and a flow meter 218, both described below, based on the measured temperature is disposed near the bottom of the plating tank 200.

(0047)

In this embodiment, the electroless plating unit 20 also has a heating device 222, which is separated therefrom, for using water which is heated by the heater 216 and passes through the flow meter 218 as a thermal medium, and indirectly heating the plating solution with a heat exchanger 220 disposed in the plating solution in the plating solution supply tank 202, and a stirring pump 224 for circulating and stirring the plating solution in the plating solution supply tank 202. This arrangement lends itself to a situation where the plating solution is used at a high temperature (about 80°C). This process is more effective to prevent unwanted substances from being mixed with the plating solution which is very delicate than the in-line heating process.

(0048)

With the electroless plating unit 20, while the plating solution in the plating tank 200 is being circulated, the substrate W held by the substrate holding head 38 is rotated and lowered into the plating solution in the plating tank 200. At this time, a plating solution managing device 240 associated with the plating tank 200 keep the temperature of the plating solution, the composition of the plating solution, and the concentrations of the components of the plating solution in predetermined ranges. After the substrate W is immersed in the plating solution for a predetermined time, the substrate W is pulled upwardly to a given position above the plating tank 200, and the substrate holding head 38 is stopped against rotation, whereupon the plating process is ended. By thus controlling the processing time, the film thickness of the protective film formed on the base surface to be processed of the substrate is adjusted.

(0049)

As shown in detail in FIGS. 7 through 9, the substrate holding head 38 has an attraction head 234 and a substrate receiver 236 surrounding the attraction head 234. The attraction head 234 and the substrate receiver 236 rotate in unison with each other through a splined structure upon energization of the motor 34, and are vertically movable relatively to each other upon actuation of a cylinder (not shown).

(0050)

An attraction ring 250 having a lower sealing surface for attracting and holding the substrate W is mounted by a presser ring 251 to the peripheral edge of the lower surface of the attraction head 234. A recess 250a defined circumferentially continuously in the lower surface of the attraction ring 250 and a vacuum line 252 extending in the attraction head 234 communicate with each other through a communication hole 250b defined in the attraction ring 250. The recess 250a can thus be evacuated to attract and hold the substrate W. Since the substrate W is held under a vacuum created in a circumferential pattern having a small width (in the radial direction), any effect (flexure, etc.) that the vacuum has on the substrate W is minimized. The substrate W can be released when N_2 is supplied to the vacuum line 252.

(0051)

The substrate receiver 236 is of a downwardly open bottom cylindrical shape, and has a substrate insertion windows 236a defined in a circumferential wall thereof for inserting the substrate W therethrough into the substrate receiver 236, and a circular substrate guide 254 disposed on a lower end thereof and projecting inwardly. The substrate guide 254 has a seal ring 254a disposed on an inner circumferential end thereof and projecting slightly upwardly. Protrusions 256 each having a tapered surface 256a on its inner circumferential surface as a guide for the substrate W are disposed on the upper end of the substrate guide 254.

(0052)

As shown in FIG. 7, with the substrate receiver 236 being lowered, the substrate W is inserted into the substrate receiver 236 through the substrate insertion window 236a.

The substrate W is guided and positioned by the tapered surfaces 256a of the protrusions 256, and placed and held in a given position on the upper surface of the substrate guide 254. Then, the substrate receiver 236 is lifted until the upper surface of the substrate W placed and held on the substrate guide 254 of the substrate receiver 336 abuts against the attraction ring 250 of the attraction head 234, as shown in FIG. 8. The substrate receiver 236 is further lifted to press the seal ring 254a of the substrate guide 254 against the lower surface of the peripheral edge of the substrate W. Thus, the substrate is held with the lower surface of the peripheral edge of the substrate W being sealed by the seal ring 254a.

(0053)

For pre-treating the substrate W, for example, the recess 250a in the attraction ring 250 is evacuated through the vacuum line 252, as described above, to attract the substrate W while sealing the peripheral edge of the upper surface of the substrate W with the lower surface of the attraction ring 250. Then, the pretreatment liquid is ejected to the surface (lower surface) of the substrate W to pre-treat the substrate W for thereby preventing a catalyst from being imparted to the peripheral edge of the substrate W. For rinsing and plating the substrate W, as shown in FIG. 9, the substrate receiver 236 is lowered by a distance ranging from several mm to several tens mm, separating the substrate W from the substrate guide 254 and attracting and holding the substrate W only with the attraction ring 250. The peripheral edge of the surface (lower surface) of the substrate W is now purified by the rinsing liquid. Even if the peripheral edges of the face and reverse sides of the substrate are not sealed during the plating process, since no catalyst is applied to those peripheral edges, the peripheral edges of the substrate are not contaminated in the plating process.

(0054)

In this embodiment, as shown in FIG. 10A, the seal ring 254a of the substrate guide 254 is pressed against the lower surface of the peripheral edge of the substrate W to seal the lower surface of the peripheral edge of the substrate W with the seal ring 254a. Then, the spray nozzles 124a of the nozzle plate 145 eject the pretreatment liquid to the

substrate W to perform pretreatments, i.e., a purifying treatment and a catalyst imparting treatment, on the substrate W. As shown in FIG. 10B, the substrate W is attracted and held while sealing the peripheral edge of the upper surface of the substrate W with the lower surface of the attraction ring 250, and the substrate W is spaced from the substrate guide 254. Then, the spray nozzles 112a of the nozzle plate 112 eject the rinsing liquid, such as electrolyzed ion water having reducing power, or an aqueous liquid having one component or mixed components of an electroless plating solution, to the substrate W, thereby rinsing away the pretreatment liquid that is applied to the substrate W. Furthermore, as shown in FIG. 10C, the substrate W is attracted and held while sealing the peripheral edge of the upper surface of the substrate W with the lower surface of the attraction ring 250, and the substrate W is spaced from the substrate guide 254. Then, the substrate W is immersed in the plating solution in the plating tank 200, so that the surface of the substrate is plated.

(0055)

The post-cleaning unit 24 serves to remove the plating solution remaining on the surface of the substrate W plated by the electroless plating unit 20, and also simultaneously to clean the reverse side of the substrate W. The post-cleaning unit 24 is also arranged to rotate the substrate W at a high speed to spin-dry the substrate W.

(0056)

Specifically, the post-cleaning unit 24 has a substrate stage for detachably holding the substrate W with a clamp mechanism and rotating the substrate W at a high speed, and cleaning liquid supply nozzles for supplying a cleaning liquid such as pure water, a chemical solution, or the like to both the face and reverse sides of the substrate held by the substrate stage. While the substrate held by the substrate stage is being rotated, the face and reverse sides of the substrate are supplied with the cleaning liquid such as pure water, a chemical solution, or the like to remove the plating solution remaining on the surface of the substrate W and simultaneously to clean the reverse side of the substrate.

Furthermore, the substrate W is rotated at a high speed by the substrate stage to spin-dry the substrate W which has been post-cleaned.

(0057)

An electroless plating process performed by the substrate processing apparatus will be described below with reference to FIG. 11. In this embodiment, an electroless plating process for selectively forming a protective film (cap material) 9 made of a Co-W-P alloy film to protect the interconnects 8, as shown in FIG. 1, will be described below.

(0058)

First, one substrate W is taken by the first transfer robot 26 out of the substrate cassette 10 placed on the loading/unloading unit 12 which stores substrates W each having interconnects 8 (see FIG. 1) on its surface, with their surfaces facing upwardly, and transferred to the film thickness measuring unit 22. The substrate W placed on the film thickness measuring unit 22 is received by the second transfer robot 28, which inverts the substrate W by 180° and transfers the substrate W to the substrate holding head 38. Specifically, as described above, with the substrate receiver 236 being lowered, the substrate W is inserted into the substrate receiver 236 through the substrate insertion window 236a. The substrate receiver 236 is lifted to press the seal ring 254a of the substrate guide 254 against the lower surface of the peripheral edge of the substrate W to hold the substrate W.

(0059)

Then, the swing arm 32 is pivoted to move the substrate holding head 38 to the position directly above the pretreatment unit 18. The lid 102 is moved from the position covering the upper end opening of the inner tank 100a of the processing tank 100 to the retracted position, and the substrate holding head 38 is lowered into a position in the inner tank 100a of the processing tank 100. The spray nozzles 124a of the nozzle plate 124 disposed in the inner tank 100a ejects the pretreatment liquid to the substrate W which has been held and rotated by the substrate holding head 38, thereby pre-treating the surfaces of the interconnects 8. For example, the pretreatment liquid has a liquid temperature of

25°C, and comprises a mixed solution of 0.005 g/L of $PdCl_2$ and 0.2 ml/L of HCl. In this manner, metal oxide film on the surfaces of the interconnects 8 is removed and CMP residues remaining on the surfaces of the interconnects 8 are removed, and at the same time a catalyst of Pd is applied to the surfaces of the interconnects 8. That is, Pd nuclei as catalyst nuclei (seeds) are formed on the surfaces of the interconnects 8, activating the exposed surfaces of the interconnects 8. As described above, the pretreatment liquid purifying device 140 may be provided for measuring the concentration of impurities such as of copper or the like which have been mixed in the pretreatment liquid by the catalyst imparting treatment and removing the impurities when the concentration thereof reaches a predetermined value, so that the used pretreatment liquid may be circulated for reuse.

(0060)

Then, the substrate holding head 38 is temporarily lifted so that the substrate W is attracted and held while sealing the peripheral edge of the upper surface of the substrate W with the lower surface of the attraction ring 250, as described above, and then the substrate W is spaced from the substrate guide 254. Subsequently, the lid 102 is positioned in covering relation to the upper end opening of the inner tank 100a, and the nozzles 112a of the nozzle plate 112 eject the rinsing liquid, such as electrolyzed ion water having reducing power, or an aqueous liquid prepared by mixing one component or some components of an electroless plating solution, to the substrate W, thereby rinsing off the pretreatment liquid applied to the substrate.

(0061)

Next, while the substrate holding head 38 is holding the substrate W, the substrate holding head 38 is moved to a position directly above the electroless plating unit 20. With the plating solution being circulated in the plating tank 200, the electroless plating process is performed on the surface of the substrate W. Specifically, for example, the substrate W is immersed in a plating solution of Co-W-P at a liquid temperature of 80°C for 120 seconds, for example, to selectively perform the electroless plating process (electroless Co-W-P plating) on the surfaces of the activated interconnects 8. Thereafter, the substrate

holding head 38 is lifted. In this manner, an interconnect-protective 9 made of a Co-W-P alloy film is selectively formed on the surfaces of the interconnects 8 to protect the interconnects 8. The plating solution may have the following composition, for example:

(0062)

·$CoSO_4 \cdot 7H_2O$: 14 g/L

·$Na_3C_6H_5O_7 \cdot 2H_2O$: 70 g/L

·H_3BO_3 : 40 g/L

·$Na_2WO_4 \cdot 2H_2O$: 12g/L

·$NaH_2PO_2 \cdot H_2O$: 21 g/L

·pH : 9.5 (adjusted by NaOH)

The volume, the temperature, and the components of the plating solution are kept in predetermined ranges by the plating solution managing device 240.

(0063)

It is preferable to fill or circulate an inactive gas or a reducing gas in the space partitioned by the partition wall 42 to keep an atmosphere having less oxygen than the atmosphere in the space, and to pre-treat, rinse, and plate the substrate in that atmosphere. In this manner, an oxide film is prevented from being regenerated on the surfaces of the interconnects 8 to which the catalyst has been imparted, and the protective film is prevented from being oxidized during film deposition, thus forming an protective film of stable film properties.

(0064)

By thus performing a series of processes from bringing the substrate into contact with the pretreatment liquid to drying the substrate in a housing 16 without exposing the surface to be processed of the substrate to light, it is possible to eliminate the light-excited motion of electrons in devices and interconnects formed in a device surface of the substrate while the substrate is being processed, preventing damage from being made to the substrate devices.

(0065)

The plated substrate is transferred from the substrate holding head 38 to the second transfer robot 28, inverted 180°, and then transferred to the post-cleaning unit 24. In the post-cleaning unit 24, while the substrate W is being held and rotated by the substrate stage, the cleaning liquid such as pure water or the like is supplied to the face and reverse sides of the substrate W to clean the face and reverse sides of the substrate W. The substrate stage further rotates the substrate W at a high speed to spin-dry the substrate W after the post-cleaning treatment.

(0066)

The spin-dried substrate W is then transferred by the second transfer robot 28 to the film thickness measuring unit 22, which measures a film thickness of the interconnect-protective film 9 which is formed on the surfaces of interconnects 8. After the film thickness is measured, the substrate W is returned by the first transfer robot 26 into the substrate cassette 10 placed on the loading/unloading unit 12.

(0067)

The film thickness, which is measured on-line, of the protective film 9 formed on the exposed surfaces of the interconnects 8 is fed back before the electroless plating process is performed on a next substrate, and the processing time or the components of the plating solution in the plating process on the next substrate are adjusted depending on a change in the film thickness, for thereby controlling the film thickness of the protective film that is formed on the surface of the base layer to be processed on the substrate.

(0068)

In the present embodiment, a desired liquid such as pure water or the like can be used as the rinsing liquid for rinsing the pretreatment liquid that remains on the substrate after the catalyst imparting treatment.

In the above embodiment, the Co-W-P alloy film is used as an interconnect-protective film 9. However, an interconnect-protective film made of Co-P, Co-W-B, Co-B, Ni-W-P, Ni-P, Ni-W- B, Ni-B, or the like may be used. While copper is used as the

interconnect material in the above embodiment, a copper alloy, silver, a silver alloy, gold, a gold alloy, or the like may be used as the interconnect material in addition to copper.

(0069)

(EFFECT OF THE INVENTION)

As described hereinabove, according to the present invention, by successively performing processes for forming a protective film selectively on the base surface to be plated of the substrate according to electroless plating, the overall apparatus is more compact, does not require a wide installation space, has a lower initial cost and a lower running cost, and can form an interconnect-protective film within a shorter processing time, than would be if the processing steps were performed by separate units (processing units). In particular, waiting times or transfer times for the substrate between the processing steps can be adjusted to extremely short times, or it is possible to form a high-quality protective film while preventing its electrical characteristics from being lowered by successively performing surface cleaning, catalyst imparting, rinsing, and plating processes in a hardly oxidizing atmosphere.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(FIG. 1)

FIG. 1 is a cross-sectional view showing an interconnect-protective film formed by electroless plating.

(FIG. 2)

FIG. 2 is a plan view showing the layout of a substrate processing apparatus according to an embodiment of the present invention.

(FIG. 3)

FIG. 3 is a front view of a pretreatment unit at the time a substrate is transferred.

(FIG. 4)

FIG. 4 is a front view of the pretreatment unit at the time a catalyst imparting treatment is performed.

(FIG. 5)

FIG. 5 is a front view of the pretreatment unit at the time a purifying treatment is performed and a catalyst chemical solution is rinsed.

(FIG. 6)

FIG. 6 is a systematic view of the pretreatment unit and an electroless plating unit.

(FIG. 7)

FIG. 7 is an enlarged fragmentary cross-sectional view of a substrate holding head at the time a substrate is transferred.

(FIG. 8)

FIG. 8 is an enlarged fragmentary cross-sectional view showing the manner in which a substrate receiver of the substrate holding head is lifted and a seal ring of a substrate guide is pressed against the lower surface of the peripheral edge of the substrate to hold the substrate.

(FIG. 9)

FIG. 9 is an enlarged fragmentary cross-sectional view showing the manner in which the substrate is attracted while the peripheral edge of the lower surface of the substrate on the substrate holding head is being sealed by the lower surface of an attracting ring, and the substrate is spaced from the substrate guide.

(FIG. 10)

FIG. 10(a) is a schematic view showing the manner in which a substrate is pre-treated (in a purifying treatment and a catalyst imparting treatment), FIG. 10(b) is a schematic view showing the manner in which a chemical solution applied to the substrate is rinsed, FIG. 10(c) is a schematic view showing the manner in which the surface of the substrate is plated.

(FIG. 11)

FIG. 11 is a diagram showing a process flow of the substrate processing apparatus shown in FIG. 2.

(EXPALANATION OF THE REFERENCE NUMERALS)

8 interconnect

9	protective film
10	substrate cassette
12	loading/unloading unit
16	housing
18	pretreatment unit
20	electroless plating unit
22	film thickness measuring unit
24	post-cleaning unit
30	turn shaft
32	swing arm
34	motor
36	output shaft
38	substrate holding head
40	air supply/discharge system
42	partition wall
100	processing tank
100a	inner tank
100b	outer tank
102	lid
104	leg
106	crank
108	lid moving cylinder
112, 124	nozzle plate
112a, 124a	spray nozzles
120	pretreatment liquid tank
126	drainpipe
132	rinsing liquid supply source
140	pretreatment liquid purifying device

200	plating tank
202	plating solution supply tank
210	plating solution retrieval groove
216	heater
218	flow meter
220	heat exchanger
222	heating device
224	stirring pump
234	attraction head
236	substrate receiver
240	plating solution managing device
250	attraction ring
252	vacuum line
254	substrate guide
254a	seal ring

(NAME OF DOCUMENT) ABSTRACT

(ABSTRACT)

(PURPOSE) There is provided a substrate processing method which is capable of lowering the initial cost and the running cost of an apparatus, does not require a wide installation space, does not particularly degrade electrical characteristics, and is capable of efficiently forming a high-quality protective film.

(MEANS FOR SOLUTION) A substrate processing method for forming a protective film on bottom surfaces and side surfaces of recesses for embedded interconnects provided in a surface of a substrate or exposed surfaces of interconnects provided in a surface of a substrate, including: performing a catalyst imparting treatment by bringing a pretreatment liquid into contact with a base surface to be plated of the dry substrate to activate the surface, and removing the pretreatment liquid remaining on the surface of the substrate in a rinsing treatment; performing an electroless plating process on the base surface to be processed, to which the catalyst has been imparted, to form the protective film selectively; and post-cleaning the substrate after the electroless plating process and drying the substrate.

(SELECTED DRAWING) FIG. 11

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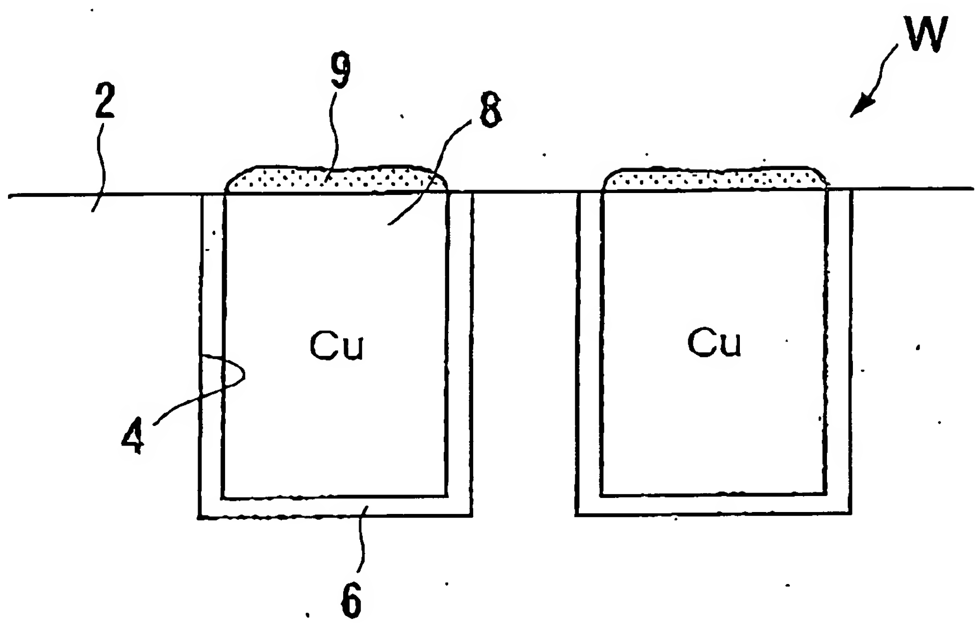
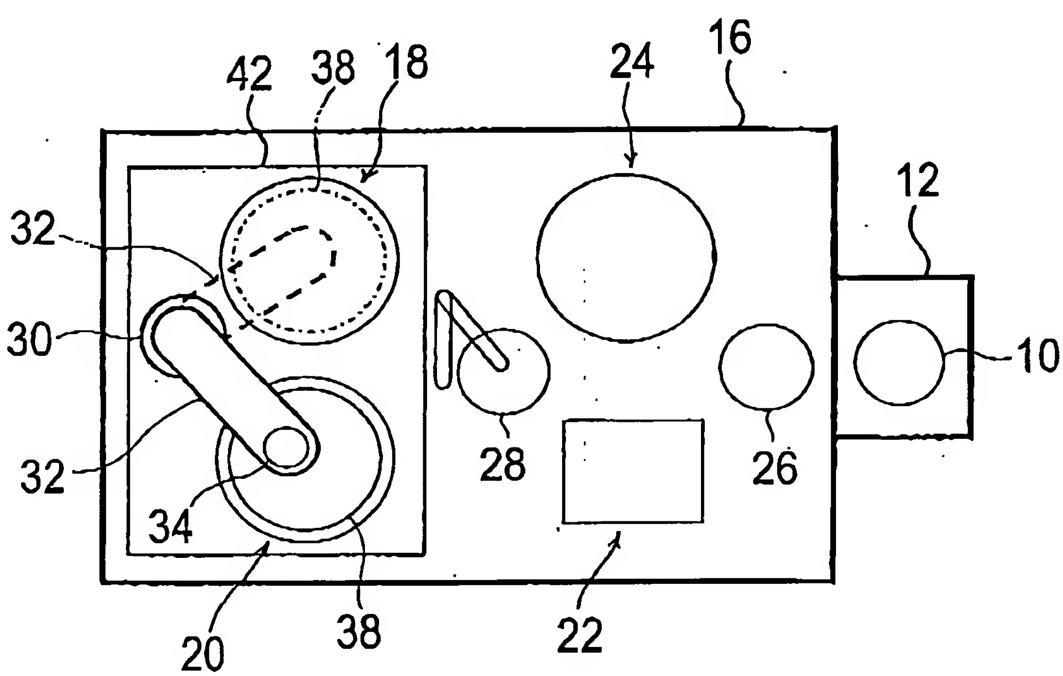
REFERENCE NUMBER = EB3001P Application No. 2003-078485

(NAME OF DOCUMENT) DRAWINGS

(FIG. 1)



(FIG. 2)



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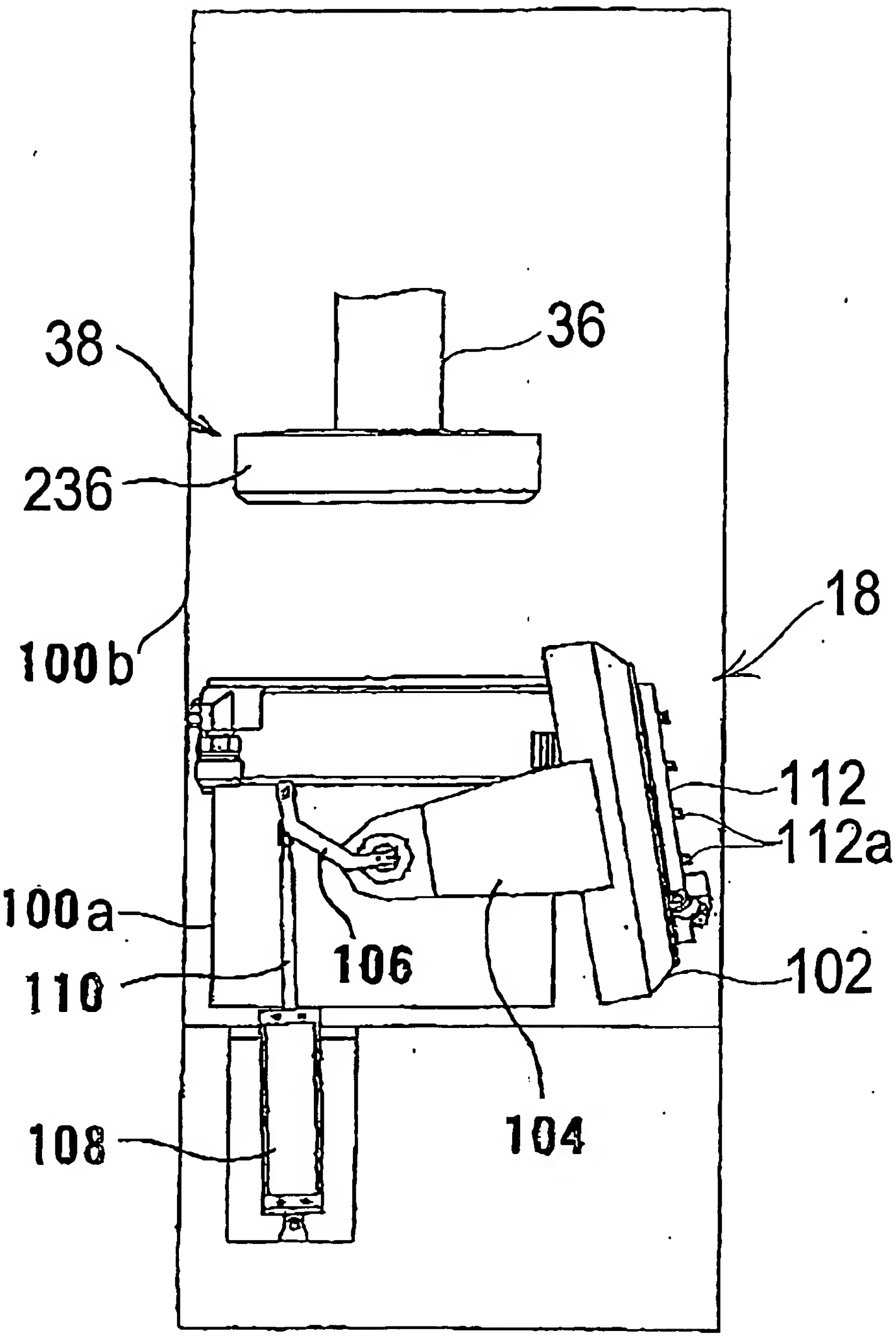
(FIG. 3)



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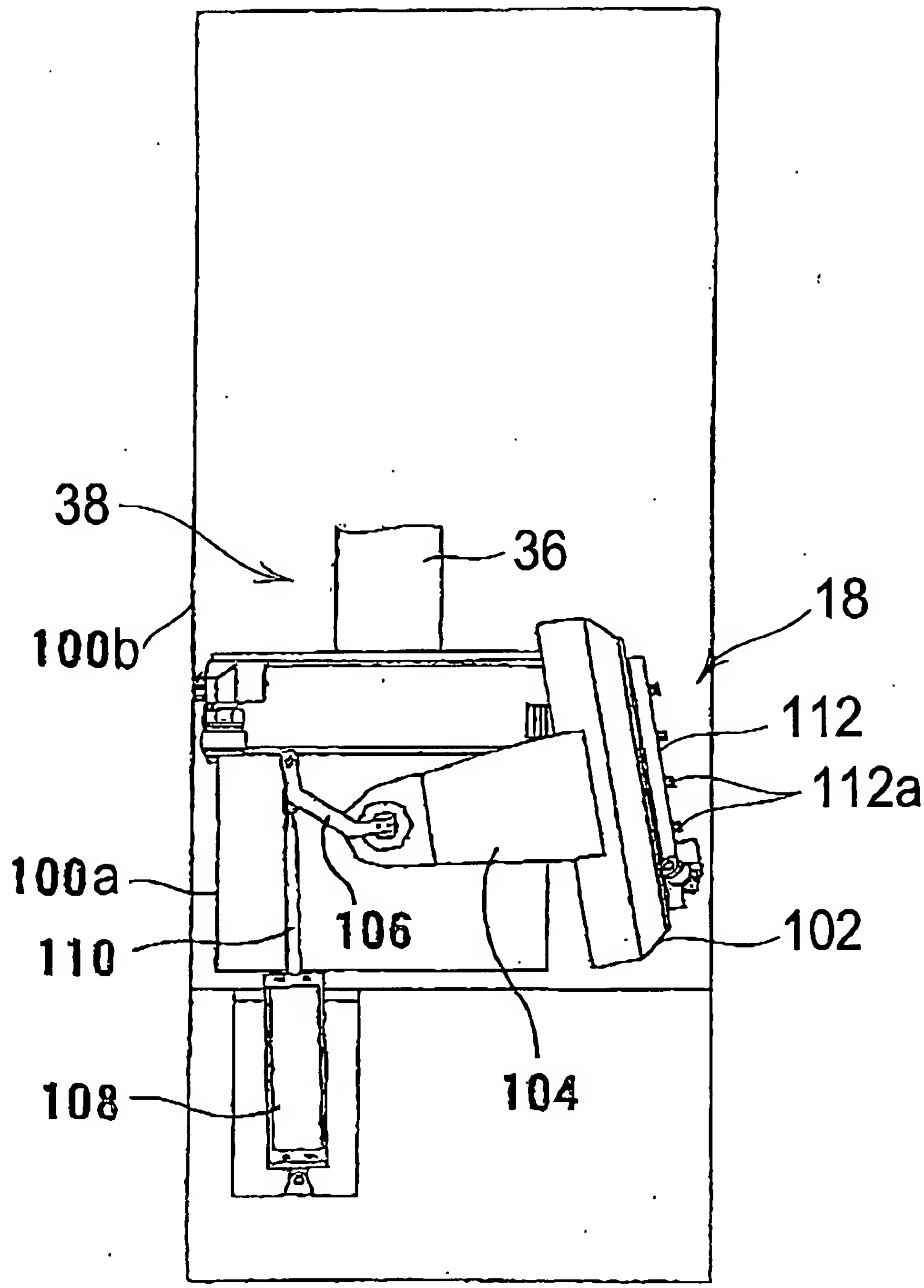
(FIG. 4)



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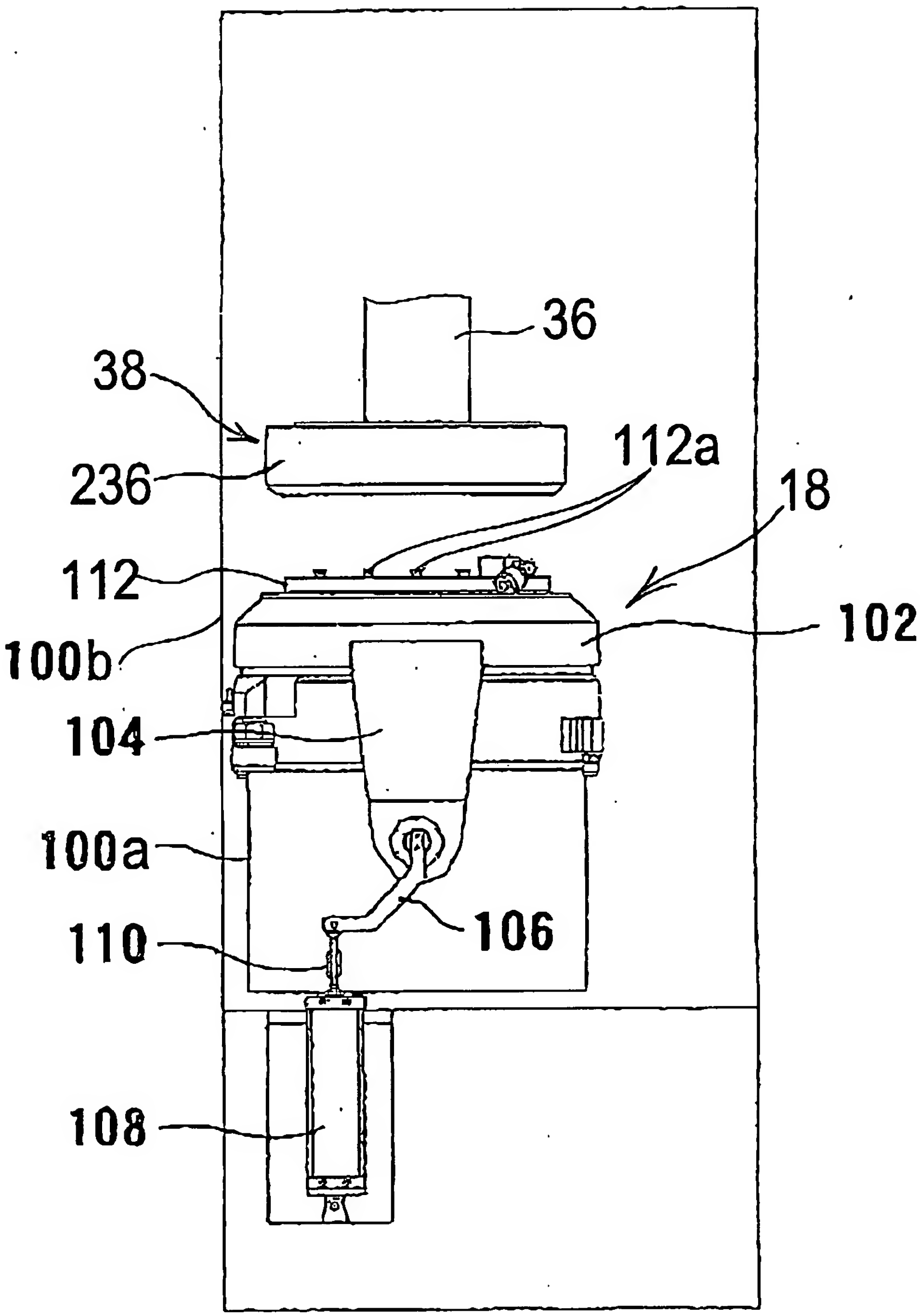
(FIG. 5)



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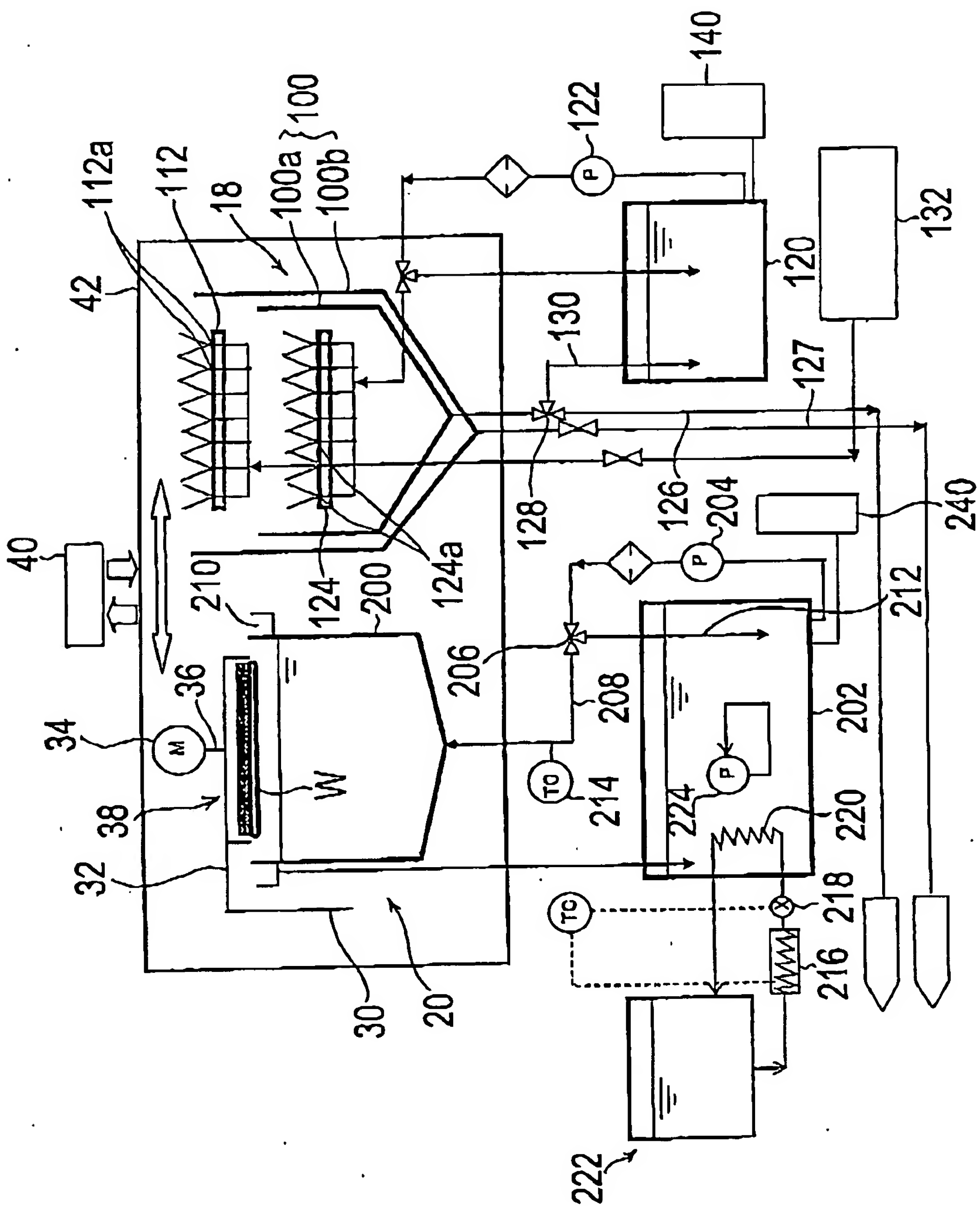
(FIG. 6)



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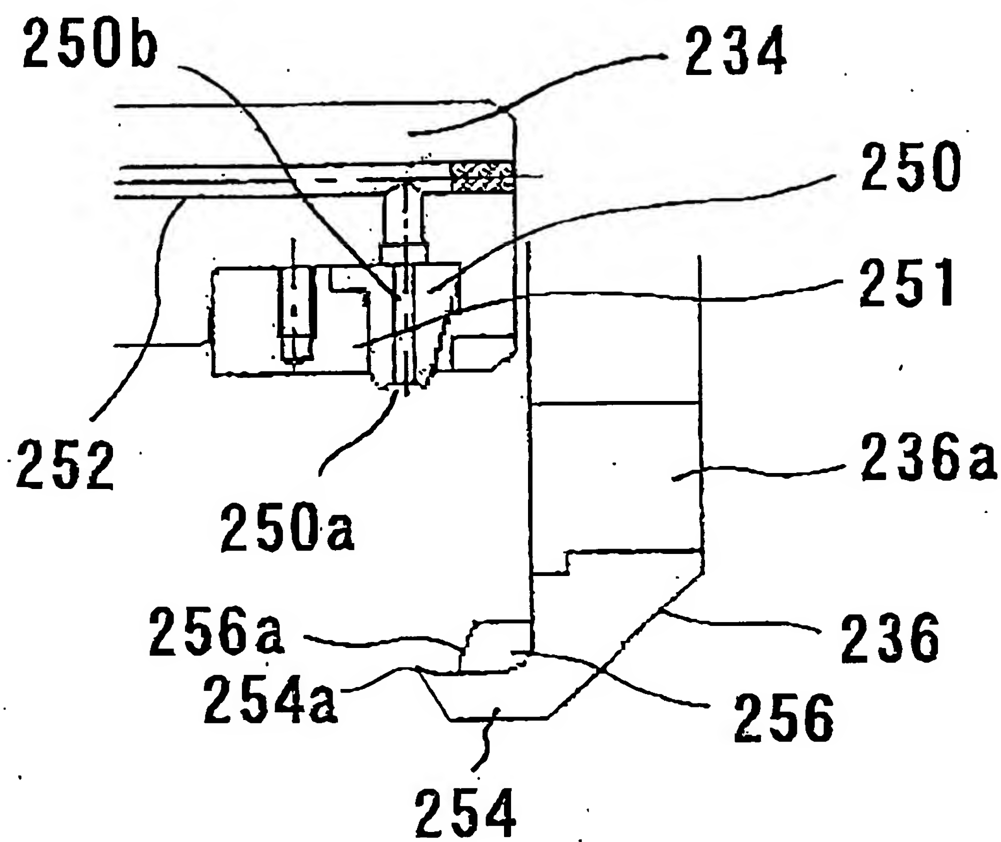
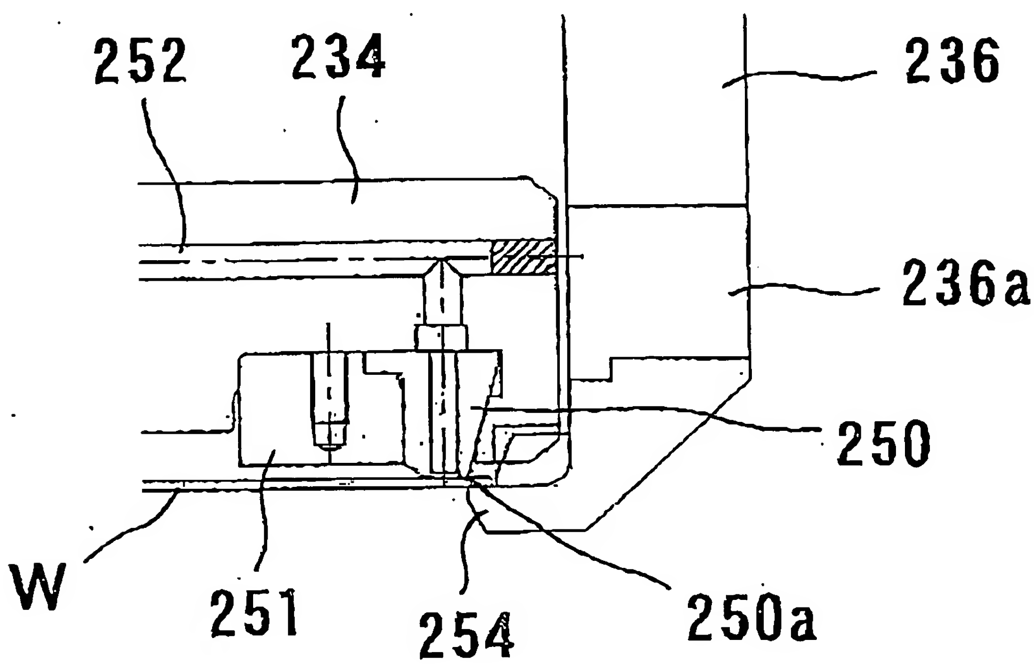
(FIG. 7)



(FIG. 8)



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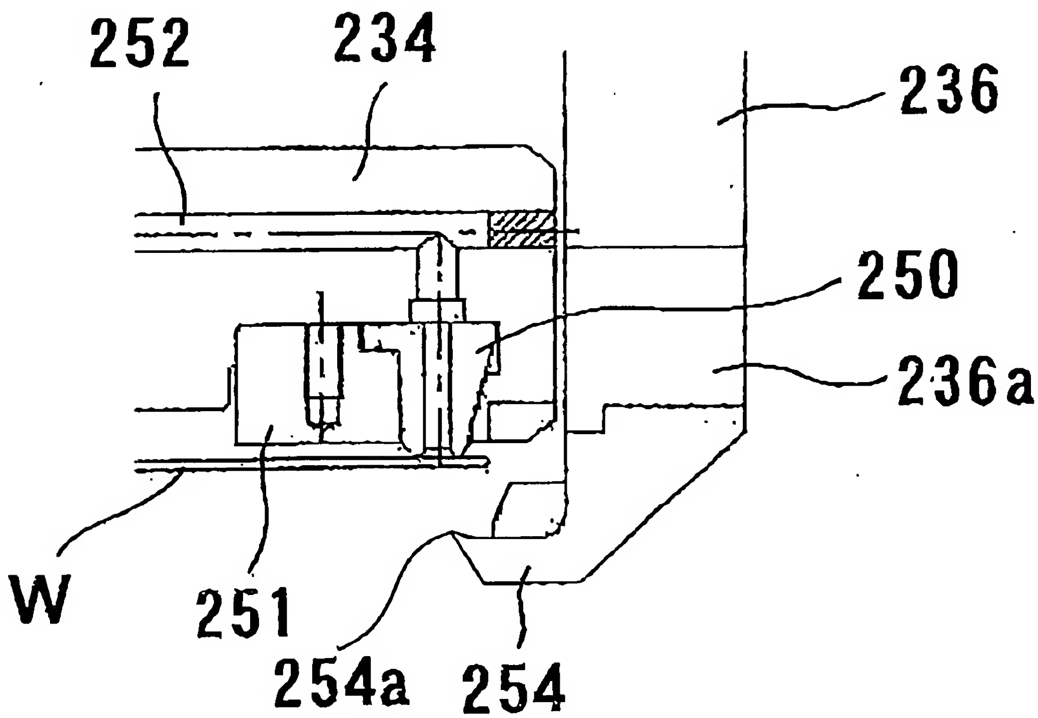
(FIG. 9)



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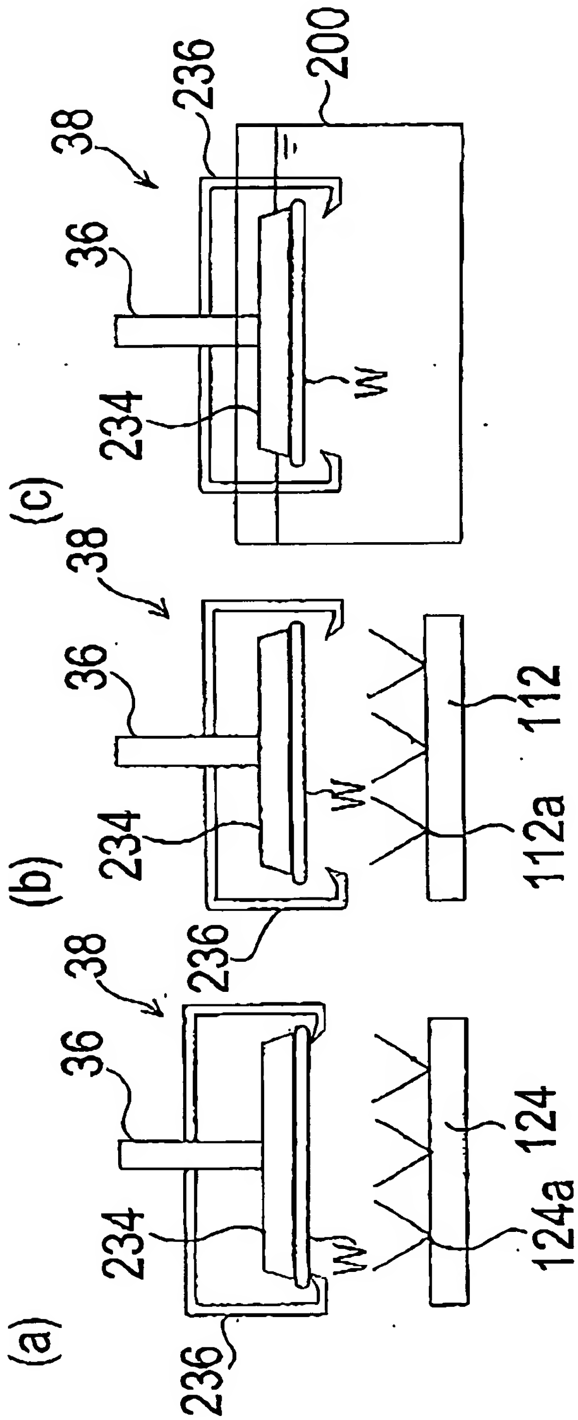
(FIG. 10)



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(FIG. 11)